[redacted]NCLOSURE SYSTEM FOR TRAMP[redacted]NE

Background of the Invention

The present invention concerns wall structures used with trampolines to protect trampoline users and to provide new uses for trampolines.

In the past, trampolines have been used for a variety of athletic and recreational purposes. However, injuries have sometimes resulted when a person jumping on a trampoline would land too near the boundary of the rebounding surface and strike the trampoline frame or fall off an elevated trampoline.

To reduce such injuries, devices have been made to form a wall around the perimeter of a trampoline bed so that when a jumper lands too near the edge, the wall prevents the jumper from falling off. For the most part, these devices have been passive walls which do not assist a jumper, except for providing basic protection, and which do not add anything to the experience of using a trampoline. Thus, there is a need for a trampoline enclosure system that does more than provide basic, wall-like protection.

Summary of the Invention

The present invention is a wall enclosure system which not only provides protection for a trampoline jumper, but also actively responds to an impact by urging the jumper back toward the center of the rebounding surface of the trampoline.

The present system has several unique structural features which make the wall active in response to an impact. These features also make the system easy to install and universally applicable to almost all types of trampolines. The construction of the present system also makes it possible to mount a variety of game accessories so that a jumper can use the trampoline for purposes not possible in the past. A variety of new games are made possible by these constructions.

These and other unique features of the invention will be understood with referenced to the following detailed description and drawings.

APPENDIX A

In the Drawings

Fig. 1 is an oblique view showing a trampoline apparatus including an enclosure system according to the present invention.

Fig. 2 is top plan view of the apparatus shown in Fig. 1.

Fig. 3 is an enlarged oblique view of a leg portion of the apparatus shown in Fig. 1.

Figs. 4, 4a are enlarged partial oblique views of a wall portion of the apparatus shown in Fig. 1.

Fig. 5 is an enlarged partial side view of the apparatus shown in Fig. 1.

Figs. 6, 6a are an enlarged views of an end cap shown in Fig. 5.

Fig. 6b illustrates a door structure.

Fig. 7, 7a are views of another trampoline apparatus including an enclosure system according to the present invention.

Fig. 8 is an oblique schematic view of the apparatus shown in Fig. 7.

Figs. 9-14 are views of various alternative constructions and accessories.

Detailed Description

Trampolines come in a variety of configurations and sizes. A popular trampoline is shown in Figs. 1-2. The illustrated trampoline has a circular frame 34 supported by multiple U-shaped tubular legs 36. The U-shaped legs have two vertically-extending sections 37 connected by a horizontal section which rests on the ground. The upper ends of the vertical leg sections 37 are secured to the frame 34 by welds. For ease in storage, it is convenient for the legs to be removable. This is made possible by providing a swage joint 38 in each vertical leg section 37. A plurality of spring members 39 tautly attach a sheet of sturdy fabric 40 to the frame 34 so that the fabric provides a rebounding surface or bed. Other types of trampolines, having variations in structure such as individual legs secured by bolts or the like, will equally benefit from the present invention.

The trampoline is augmented by an enclosure system 30 which provides a protective and interactive environment for the trampoline user. The system 30 includes a plurality of posts 44 which extend vertically. Each post 44 is secured to a vertical section 37 of one of the legs 36. For the purpose of this disclosure, each

post 44 is referred to as having an upper end portion 46, a wall support portion 48 located above the level of the rebounding surface 40, a lower portion 50 located below the surface 40, and a lower end portion 52 which extends to ground level. These designations refer to locations on a post 44, not to separable sections. In the illustrated embodiment, each post 44 is made in two sections and connected at a swage joint 54, with the two pieces secured together by a set screw. A single-piece post could also be used, or a post comprised of more than two pieces secured end-to-end with swage fittings and set screws. A multi-piece post is easier to package and ship than a unitary post.

Each post is connected to a leg by two leg fasteners 58, 60. As best seen in Fig. 3, the upper fastener 58 is an assembly having two U-bolts 64. The U-bolts have threaded ends 65. In use, the U-bolts are positioned to encompass the frame 34 on opposite sides of the vertically extending portion 37 of a leg 36. Two saddle clamps 66 are respectively positioned above and below the frame 34. Each clamp 66 has two openings which respectively receive one threaded end 65 of each of the two U-bolts. Nuts 68 are tightened onto the threaded ends 65 of the U-bolts 64 in order to secure the post 44 to the frame 34. To provide a degree of flexibility in the fasteners 58, stiff compression springs (not shown) could be provided between the saddle clamps 66 and nuts 68. In this arrangement, locking nuts would be used, and the nuts would not be tightened to that extent that the springs were completely crushed. With such springs in place, a post 44 could be moved a short distance away from the frame 34 when a person bounced against the post from inside the chamber 106. The additional movement of the pole would help cushion the impact on the person.

A rigid, smooth-surfaced cap 82 is provided on the outside of each upper fastener 58 to cover all the threaded ends 65 of the U-bolts. The caps 82 protect persons from coming into contact with the threaded ends 65 of the U-bolts 64, which ends are somewhat sharp. Each cap 82 has rounded corners and is secured in place over the ends 65 by a cable tie (not shown) which encompasses the cap and a diameter of the frame 34 and/or leg segment 37.

The lower fastener 60 has a single U-bolt 74 with threaded ends 75. A saddle clamp 76 is positioned over the threaded ends and held in place by nuts 78. For greatest stability, the lower fastener 60 should be near the bottom of the vertical section 37 of the leg 36 so that the lower fastener 60 is well below the upper fastener 58. For safety, the lower fasteners should be positioned so that the threaded ends of the U-bolts 74 extend inwardly, toward the center of the trampoline bed 40.

It is particularly helpful for the fasteners 58, 60 to be positioned so that all swage joints 38 are located between the upper and lower fasteners 58, 60. This arrangement will prevent the swage fittings from coming apart unintentionally, as is possible during energetic use of a trampoline for game playing. It is also an advantage of this system that it reinforces the legs of the trampoline and reduces the stresses on the welds between the frame 34 and legs sections 37. Although not preferred for general use, other fastener systems can be employed as described below.

The wall support portion 48 of each post 44 is covered with a layer 84 of padding made from a resilient foam material, with or without a fabric cover. The padding may be a rectangular sheet wrapped around the post 44 and secured by fasteners or may be tubular so that there is no seam. The illustrated foam is extruded closed cell polyethylene foam. Other resilient, weather-resistant foam materials could also be used. As explained below, the foam material serves not only as cushioning for a person who impacts one of the posts 44. The foam material is used as a part of a system for momentarily storing energy from remote impacts, so that portions of foam help rebound a person toward the center of the trampoline, even when the foam is not directly impacted by the person.

In the illustrated embodiment, an end cap 86 is provided as an upper extension of each post 44. The end cap has a rounded upper portion 88, a centrally-located neck portion 90 which is a circumference channel extending around the axis A of the post 44, and a downwardly-opening collar portion 91 which is located at the base of the cap and which is of greater inside and outside diameter than the neck portion 90. The upper portion 88 is substantially spherical for strength. The neck portion 90 is

hollow and sh[illegible] to snugly fit over the upper end portion [illegible] of a post 44. The collar portion 91 is of sufficient inside diameter to receive, protect, and aid in securing the top of the padding layer 84. The cap 86 is made of a shatter-proof plastic material which is somewhat flexible at typical ambient temperatures so that the cap is capable of cushioning some impact energy.

A hook 92 is provided by an eye bolt which has a passageway 93 giving access to the center of the eye. In the illustrated embodiment, the hook is located on the end cap 86, but could be located elsewhere at or near the upper end portion 46 of the post 44. The eye bolt has a shank which extends through two vertically-aligned, registered holes through the post 44 and cap 86 at one side of the post 44. The threaded end of the shank is secured by a tee nut 94 which has a neck received in suitably-sized, registered holes through the post 44 and cap 86 at the opposite side of the post 44. Other forms of hook could be used at this location, and a hook could be secured differently, for example by one or more clevis pins extending both through a portion of the hook and through the post. A closed eye could also be used, but this would be less convenient because lines would need to be threaded through eyes during installation of a wall. The hook has several uses explained below.

A generally cylindrical wall 100 of a flexible material is suspended between the posts 44 to define a chamber 106 above the rebounding surface 40. The illustrated chamber is open at the top as shown in Fig. 1. The wall 100 has top and bottom edges 101, 102 and is made of a light-weight plastic sheet material, such as extruded plastic safety fencing, which has a unitary structure with numerous mesh-like openings 104. Woven netting, strong fabric, or other forms of plastic mesh may also be used, preferably with the top and bottom edges 101, 102 being reinforced by a hem or other finishing. Generally, the wall material will be a rectangular piece having a width which is the same as the height of the wall, and a length which is somewhat longer than the circumference of the enclosure. The openings should be no more than 2 inches across, in their largest dimensions, to prevent small children from getting their hands stuck in the openings and so that there is a sufficiently uniform-surface against which balls of most any size can be thrown during game play. Preferably the openings will be at least 1 1/2 inched

across and spaced sufficiently closely that there is good visibility through the wall 100. The fencing may take many forms; the most common have patterns of openings that are diamond-shaped or rectangular. The most preferred for the wall 100 is a pattern of diamond-shaped openings spaced at 1 3/4 inches node-to-node. The fabric of the wall 100 and the other nonmetal elements described herein are best made of materials which are abrasion-resistant and which are resistant to weathering, e.g. by exposure to UV light. Suitable materials, include polypropylene, nylon, high density polyethylene, and Dacron polyester.

A support system is provided to hold the wall 100 in place. At the top, a flexible line 108 extends post-to-post near the top of the chamber 102. For each pair of adjacent posts 44, the posts are connected by a reach of the line 108. In the illustrated embodiment the line 108, although flexible, is only somewhat elastic. The line 108 thus allows the tops of the poles to move relative to one another, but the tops of two adjacent poles can not move away from each other to any great extent. The line 108 is made of a sturdy, weather-resistant material such as 1" nylon webbing. Nylon webbing is best suited because it has little elasticity and thus will not sag after it is installed. Webbing is better than rope for the line 108 since rope has a relatively low surface area which would tend to cut into and abrade the body of a person who bounced into contact with the line 108. Webbing has a relatively high surface area and automatically rotates so that a flat face of the webbing contacts any impacting body. The flat webbing face distributes resistive force over a greater portion of a person's body and is relatively nonabrasive.

The illustrated top line 108 is a single continuous piece. The ends of the top line 108 are secured together by a buckle 110 so that the top line is a continuous loop. This is a strong construction since the buckle 110 is the only fitting connected to the line. Tension in the line 108 can adjusted by using the buckle 110 to vary the circumference of the loop. The line 108 is mounted to chokingly surround the neck portion 90 of each end cap 86. As shown in Figs. 4 and 5, this is accomplished by slipping a loop 116 of the line 108 through a metal ring 114, and then lowering the loop 116 over the top 88 of the end cap 86 to a position where the loop 116 seats in the trough of the hook 92 and extends through the neck portion 90. After the line

108 is thus installed on all the end caps and pulled to a desired tension, each ring 118 maintains its loop 116 at a small diameter so that the loop 116 can not slide up out of the neck portion 90. The ring 114 is a welded steel chain link having inside dimensions of 1" x 3/8" and having rounded edges to minimize wear of the line 108 and to protect trampoline users from injury.

The wall 100 is secured to the upper line 108 along portions of the line 108 which extends between the post 44. The wall 100 can be secured to the line 108 in a variety of ways. When using mesh-like plastic safety fence, which has numerous openings 104, it is most convenient to weave the upper line 108 through a series of openings 104 near the top edge 101 of the wall 100. This arrangement is shown in Fig. 5. With a wall 100 of plastic safety fencing material, the top line 108 is woven through each opening along the top edge 101. The weaving can skip a few openings 104 opposite each of the end caps 88 to reduce stresses at points where the top line 108 extends from the fencing to a post 44.

A similar arrangement is used to secure the bottom edge 102 of the wall 100. A strap of one inch polypropylene webbing 120 extends post-to-post at an elevation near that of the frame 34. A reach of the webbing 120 thus extends between each pair of adjacent posts 44. The webbing additionally can be secured to the frame 34 at intervals between the posts 44, by cable ties (not shown) or other fasteners, to prevent the wall from stretching to a position outwardly of the frame 34. Alternatively, the webbing 120 can be secured to the trampoline bed at the inner ends of the springs 39 which support the fabric 40 or could be secured to the annular pad (not shown) which is commonly provided over the springs. The ends of the webbing 120 are secured together by a buckle 121 so that the webbing 120 is a continuous loop.. Tension in the webbing 120 can be adjusted by using the buckle 121 to vary the circumference of the loop. The webbing 120 is connected to the base of the wall 100. With a wall of plastic safety fencing, the webbing 120 is woven through a series of openings 104 near the bottom edge 102 of the wall material. At each post 44, a loop 122 of the webbing 120 extends out of the wall 100 and is held to the post 44 by a fastener 124 such as a cable tie. The fastener should be mounted so that the loop 122 cannot move a substantial distance upwardly

along the post. A loop 122 should not extend from two immediately adjacent openings in fencing material, since this would stress the fabric near the post. Instead, some space should be allowed between the two points where the loop 122 extends from the wall 100, so that tensioned webbing 120 does not cut into the wall 100 at those points. As an alternative, the bottom edge of the fencing 100 could be secured directly to the frame 34 by a series of cable ties (not shown), without use of webbing 120. Connectors from the frame to the bottom strap can be threaded through openings pierced through perimeter padding 126.

A particularly useful feature of this invention is a securement system which holds intermediate portions of the wall 100 to the posts 44. As best seen in Fig. 5, an elastic cord 128, of the type sometimes referred to as a bungee cord or shock cord, is secured at each end so that it extends vertically along the wall support portion 48 of a post 44. In the illustrated embodiment, one end of the cord 128 has a loop received in the trough of the hook 92 near the top of the post 44 and, at its other end, has a loop connected to the lower leg fastener 58. Between its ends, the cord 128 extends in serpentine fashion through openings 104 in the wall material so that loops of the cord 128 are alternately provided on the inside and the outside of the wall 100. Outside loops 130 of each cord are aligned with one of the posts 44. Also extending along the wall support portion 48 of each post 44 is a helical wrap of webbing 134. In the illustrated embodiment, this webbing is a length of one half inch polypropylene webbing with a loop 135 at its top end. The bottom end is secured to the fastener 58, while the top loop 135 is supported on the hook 92. The strapping 134 extends helically around the outside of the padding 84 and through loops 130 to hold the cord 128 against the padding 84. The strap 134 is wrapped sufficiently tightly to hold the cord 128 against the padding 84, but not so tightly that the padding is completely crushed.

Because the wall material 100 is longer than the circumference of the enclosure, ends portions 137, 138 of the wall fabric overlap as shown in FIG. 6B. At the top, the end portions 137, 138 are secured by weaving of the line 108 through openings 104 at the top edge of the end portions. A horizontal row of openings at the tops of the two end portions 137, 138 are held with the openings in registry, and

the line 108 is threaded through adjacent openings in the rows, in serpentine fashion, so that the top edges of the end portions 137, 138 are in effect sewn together by the top line 108. At the bottom, the outer end portion 138 is secured by weaving of the line 120 through openings 104 at the bottom edge of the end portion. The bottom of the inner end portion 137 is not secured. A piece of 1/2" nylon webbing 139 is woven in serpentine fashion downwardly from the top line 108 through both the end portions 137, 138 to a location 140 between the top and bottom lines 108, 120. This webbing 139 thus sews upper regions of the end portions together. The nylon webbing continues down from the location 140 secured only to the inner end portion 137. Thus the end portions 137, 138 are not sewn together below the location 140, thus providing a flap door 141 which may be bent inwardly to permit access to the chamber 106. A free extension 142 of the webbing 139 can extend from the bottom of the inner end portion 137 to be used for tying down the bottom of the door. In the illustrated embodiment, the extension is secured by wrapping it around the bottom line 120 at the base of the door and then tying it to a removed area of the bottom line 120.

The illustrated enclosure system has walls which are strong but highly resilient. The fabric of the wall 100 is extruded plastic safety fencing which is flexible, but only somewhat elastic. Elasticity is provided by other elements. In particular, the cord 128 is elastic, the padding 84 is comprised of a plastic foam material which compressible and elastic, and the posts 44 are flexible.

When a person jumps from the trampoline surface 40 and hits the wall 100 of the enclosure, the wall moves a short distance in the direction of the force applied by the user and thereby absorbs energy and cushions the shock. All of the posts 44, because they are linked together at the top by the top line 108, flex toward the impacted portion of the wall panel. Cord loops 130 are stretched on those posts 44 which are near the region of impact. And, those loops 130 pull and tension the associated strapping 134 into the padding 84 so that the padding compresses. These actions allow the fence 100 to flex and conform to the body of the person who impacted the fence. The conformance of the fence distributes the resistive force on the person's body to provide enhance cushioning. Also, because of this arrangement

of elements, a portion of the impact energy is stored in the flexed posts 44, in the elongated cords 130, and in the crushed padding 84. This stored energy is promptly released as a force which urges the impacted portion of the wall back towards the center of the chamber 106, pushing the trampoline user with it.

To provide elasticity in this system, the posts 44 should not be rigid. The posts should be sufficiently strong that impacts by trampoline users will not permanently bend the poles. But, the posts 44 should be able to flex to some extent when a trampoline user impacts the wall 100. For ease of construction and low cost, the illustrated posts 44 are made of tubular steel. Other materials, such as pvc plastic, fiberglass and carbon fiber, can be used if they have appropriate strength and flexibility characteristics. As mentioned above, the strapping 134 should not be applied so tightly that it completely crushes the padding 84. And, the padding 84 should be made using a resilient foam. It is a further advantage of this securement system that the elasticity of the loops 130 helps to prevent the wall fabric from ripping.

As most clearly seen in Fig. 7, it is useful to provide cross-bracing straps 144 to limit the movement of adjacent posts toward or away from another. A preferred cross-bracing material is substantially inelastic nylon webbing; plastic or metal cable could also be used. The cross-bracing extends, in pairs of crossing reaches, from positions near the upper end portions 46 of two adjacent posts 44 to positions which are near the elevation of the frame 34, so that an X-shaped pair of straps extend between each pair of adjacent posts 44. The cross-bracing for a pair of adjacent posts 44 can be provided by a single length of strapping which extends in a partial figure-eight pattern among four rings including a top ring 148 and a bottom 149 on each post. The two ends of the strap 144 are secured by a buckle 152.

It is possible to tune the flexibility of various elements of the enclosure system. This can be done by adding or removing one or more sections of flexible cord, or other type of spring, to a run of inelastic strapping. For example, tension springs, such as shock cord segments, could be added to the line 108, the strap 120, the strapping 134, and/or the cross bracing 144. The addition of a short section of flexible cord imparts a small amount of elasticity to such members. For greatest

adjustability, such a member can be constructed from a series of short runs of inelastic webbing, instead of from one continuous run. A tension spring element, such as a shock cord section, can be included in each short run as desired to tune flexibility.

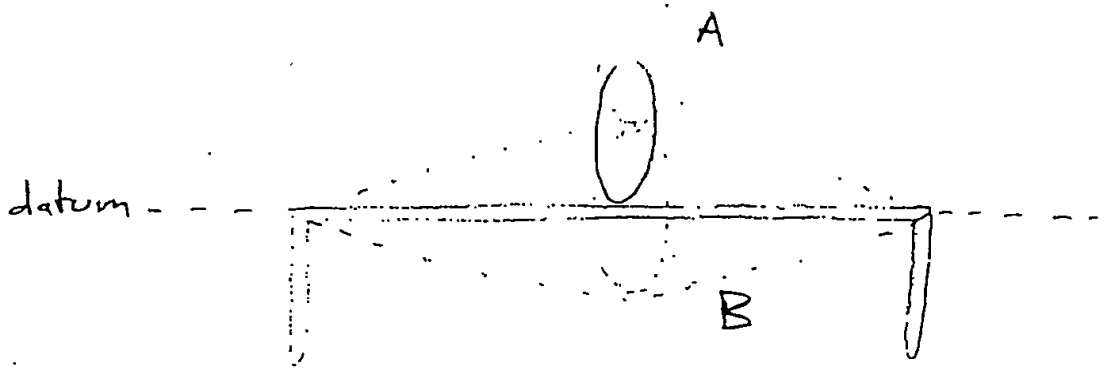
The embodiment shown in Figs. 7 and 8 is similar to the embodiment shown in Figs. 1-6, except that the enclosure system has fewer posts 44. Instead of being mounted on every vertical trampoline leg section 37, one post 44 is mounted on every other vertical leg section 37. This illustrates that the number of posts 44 and where they are mounted will depend on the size of the trampoline and the number of its legs, and the preferences of the trampoline owner. But, using the same basic set of parts, an enclosure kit can be assembled for trampolines of almost every size and shape.

Trampoline Court Specification Sheet

Category	Part Description	Dimensions	Amount	Specifications
Webbing	1" Nylon, Yellow, cut, Type 25 (upper)	45'	1	4500 lb. tensile breaking strength
	1" Polypropylene, Yellow, cut, Type 600 (lower)	45'	1	1100 lb. tensile breaking strength
	1/2" Polypropylene, Red, cut, Type 406	11'	9	375 lb. tensile breaking strength
	1/2" Polypropylene, Red, cut, Type 406	3'	8	375 lb. tensile breaking strength
Shock Cord	1/4" Shock cord	7'	7	180 lb. tensile breaking strength
Steel Tubing	Upper Support Tube, 1 3/4" O.D., 16 ga., galvanized	3'	8	Cold rolled, 1008-1010 steel
16 ga=.055 min	Lower Support Tube, 1 3/4" O.D., 16 ga., galvanized	6'	8	Cold rolled, 1008-1010 steel
Netting	Co-axial polypropylene fence, 1 1/2" x 2" mesh size	46' x 6'	1	130 lb. tensile breaking strength
Foam Tubing	Expanded polyethylene foam, 5/8" wall, 1.75" I.D.	6'	8	Closed cell, extruded, 2 lb. density
Misc Hardware	Ball End Caps, 90 Durometer, Polyvinyl Chloride (PVC)	2.75" x 2.125" x 1"	8	Made by dipping process
	U-bolt Cover Caps, 90 Durometer, Polyvinyl Chloride (PVC)	3.125" x 2.75" x 1.371"	8	Made by dipping process
	Self-tapping sheet metal screw	#12 x 5/8"	8	
	Eye Bolt, 5/16-18 w/ Zinc, C1018	1.625"	8	
	Tee Nut, 5/16-18 (prongless)	0.375"	8	
	Welded chain link (individual)	1" x 3/8"	12	
	Welded chain link (2 links)	1" x 5/8"	7	
	D-ring	1"	2	560 lb. tensile breaking strength
	Locking buckle	1"	1	360 lb. tensile breaking strength
Clamps/Saddles	Saddle clamp	1.75" I.D.	24	
U-Bolts	Cust. Lower U-Bolt, 5/16"	4.125" X 2.08"	8	
	Cust. Upper U-Bolt, 5/16"	4.375" X 2.37"	8	
Nuts	Nylock Nut, 5/16-18		48	

Energy Absorbtion Factor of Panels: 0.50 to 0.95 (50% to 95% of impact energy is absorbed)
Spring Rate of Support Poles: 5 lb/in to 45 lb/in (a measure of the stiffness of the poles)

RAMPOLINE MECHANICS

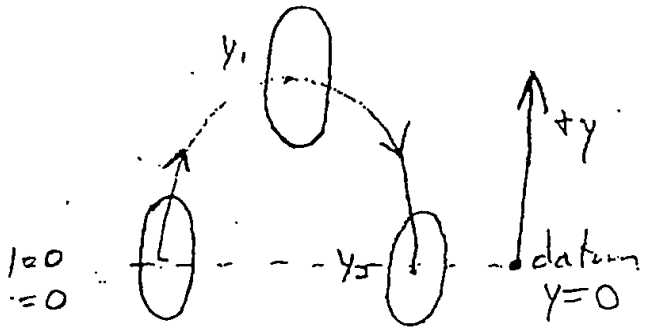


he motion of bouncing on a trampoline is
ined by two distinct phases. Phase A occurs while
ncing up into the air and is described by projectile
ion. Phase B occurs while rebounding on the bed
the trampoline and is described by standing
ve mechanics. The two phases are marked by the
mpoline bed (or the bottom of the user's feet) passing
datum line located at the position of the bed
ile at rest.

he energy added to the system can be calculated by taking
er the difference in the potential energies (height of the
os) or the kinetic energies (velocities while passing the datum)
a bounce and its preceding bounce and adding energy
in damping.

uivalent calories burned is a function of both the
al energy output to the system, and the body's ability
convert nutritional calories into energy.

Part A - Projectile Motion



Assumptions:
- Newtonian mechanics (i.e. non-relativistic equations, since velocities are much less than 0.3c)
- Air drag on the body is neglected
- Vertical motion only

Variables:
- y = vertical position relative to datum
- t = time, starting at t=0 when user's feet travel upward from the datum
- V = velocity
- $t_2 - t_0$ = total time in the air
- a = acceleration

Constants
- g = 32.2 ft/s² or 9.81 m/s² (acceleration of gravity)
- c = speed of light

Equations:

$$y(t) = y_0 + Vt + at^2$$

$$y(t) = y_0 + v_0 t + \tfrac{1}{2}at^2$$

$$y(t) = 0 + v_0 t + gt^2$$

$$y(t) = v_0 t + gt^2$$

$$v(t) = v_0 + 2gt$$

$$v_0 = v - 2gt$$

t_0: $v = v_0$

t_2: $v = -v_0$

at t_1: $v = 0$

$$0 = v_0 + 2gt$$

$$t = \frac{-v_0}{2g}$$

$$y = v_0\left(\frac{-v_0}{2g}\right) + g\left(\frac{-v_0}{2g}\right)^2$$

$$y = \frac{-v_0^2}{2g} + \frac{v_0^2}{4g} = \frac{-v_0^2}{4g}$$

at t_2: $y = 0$

$$gt^2 + v_0 t - y = 0$$

$gt^2 + v_0 t = 0$
$t(gt + v_0) = 0$
$t = 0$ or t

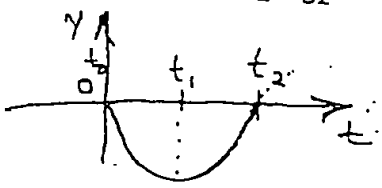
$$t = \frac{-v_0 \pm \sqrt{v_0^2 - 4 \cdot g \cdot (-y)}}{2 \cdot g}$$

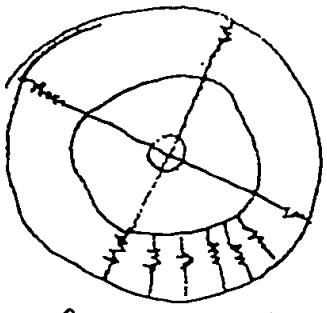
$$t = \frac{-v_0 \pm \sqrt{v_0^2}}{2g}$$

$$t = \frac{-v_0 \pm v_0}{2g} = \frac{-v_0}{g} \text{ or } \cancel{0}$$

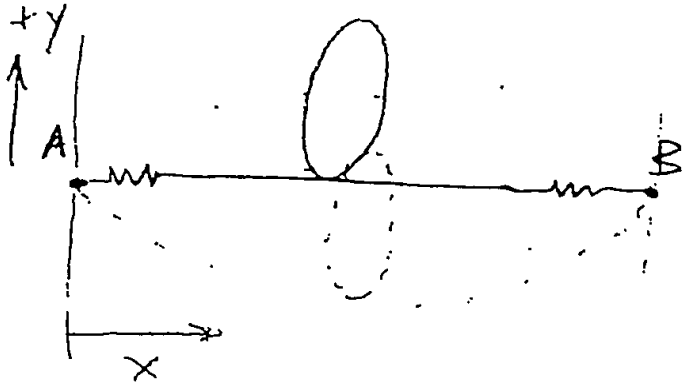
At t_A: $t_2 - t_0 = \frac{-v_0}{g} - 0 = \frac{-v_0}{g}$

Part B - Standing wave mechanics





(96 springs)



Variables

- x: horizontal position
- y: vertical position
- ω = angular velocity (rad)
- f = frequency
- T = period
- λ = wavelength
- μ = mass per unit length
- F = vertical force
- L = length of string
- M = mass of user (m) + mass of bed
- $\Delta t_B = t_2 - t_0$

Equations:

$\omega = 2\pi f$

$T = 1/f = 2\pi/\omega$

$v = \lambda f = \lambda / T$

$v = \sqrt{\frac{F}{\mu}}$

$f_n = n\frac{v}{2L} = nf_1 \quad (n = 1, 2, 3 \ldots)$

$f_1 = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$

$t_2 - t_0 = \frac{1}{2} T$

$\Delta t = T/2 = 1/2f$

$f = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$

$\mu = \frac{M}{L}$

$\Delta t = \frac{x}{2}\left(\frac{2L}{x}\sqrt{\frac{M}{FL}}\right)$

$f = \frac{1}{2L}\sqrt{\frac{FL}{M}}$

$\Delta t_B = L\sqrt{\frac{M}{FL}} = \sqrt{\frac{ML^2}{FL}} = \sqrt{\frac{ML}{F}}$

$$\Delta t_{Tot} = \Delta t_A + \Delta t_B$$

$$\Delta t_{Tot} = -\frac{V_o}{g} + \sqrt{\frac{M \cdot L}{F}}$$

$$V_o = g\left(\sqrt{\frac{M \cdot L}{F}} - \Delta t_{Tot}\right)$$

Kinetic energy $KE = \frac{1}{2} m V_o^2$

Energy added to system $\Delta E = KE_2 - KE_1$

$$\Delta E = \frac{1}{2} m V_{o_2}^2 - \frac{1}{2} m V_{o_1}^2 = \frac{1}{2} m \left(V_{o_2}^2 - V_{o_1}^2\right)$$

$$\Delta E = \frac{1}{2} m \left[\left(g\left(\sqrt{\frac{M \cdot L}{F}} - \Delta t_{Tot_2}\right)\right)^2 - \left(g\left(\sqrt{\frac{M \cdot L}{F}} - \Delta t_{Tot_1}\right)\right)^2\right]$$

$$\Delta E = \frac{1}{2} m g^2 \left[\left(\sqrt{\frac{M \cdot L}{F}} - \Delta t_{Tot_2}\right)^2 - \left(\sqrt{\frac{M \cdot L}{F}} - \Delta t_{Tot_1}\right)^2\right]$$

Calories Burned

Approx conversion rate for humans $C = 0.20 = 20\%$

$$\Delta E = (Calories)(C)$$

$$Calories = \frac{\Delta E}{C} = 5 \cdot \Delta E$$

A variety of new games have been developed to make use of the features of the enclosure system of the present invention. These games in some instances employ accessories to the basic enclosure system, as described below.

Tramp Chase. Players start in diagonal quadrants. At least two cords are stretched across a court, and hoops or other obstacles may be attached to them. Someone says go, and the players race around in the same direction, either over or under each of the cords, which the players have determined. Player wins by catching to and tagging his opponent.

Tramp Ball. Players are on either side of the net stretched across the court. Net is placed higher for more challenge. Ball is soft Nerf-type about the same size as a soccer ball. Players throw or hit it over the net. If opponent misses the ball and hits the back most panel of the court a point is scored. Opponent has one bounce of his ball on the trampoline or less to catch ball and throw or hit it back to the other side.

Tramp Shot. Two bungee cords stretched across the court, one high and one low, suspend a target. The target consists of three disks which may rotate. A small, soft, bouncy Nerf-type ball about 4 inches minimum is used. Players may move anywhere in the court. A player serves by hitting the ball at the target, if it misses, the opponent gets a point and the serve.

Tramp Back. Players start anywhere in the court. Target is a large (3' diameter) plastic disk mounted securely against one pole. Ball is small, soft, and bouncy but lightweight, pneumatic-type plastic ball, about 4 inches in diameter. Players may move around in the court. One serve is by hitting or throwing the ball against the target. Opponent has one bounce of the ball against the trampoline to catch the ball, and may only take one step before throwing the ball back at the target.

Tramp Scotch. Many cords are cris-crossed across the court at the same or varying heights. Players must jump over one square to another in a player-determined sequence. For more challenge, players may not touch any of the cords when making the jumps.

Tramp Pass. Two circular targets (3' in diameter) are securely attached to opposing poles in the court. Each is covered with Velcro covered the hook side of

Velcro fastener. A small, soft, medium-weight ball is covered with Velcro loop fastener. A cord along the surface of the tramp separates the two players. Players throw the ball at the opponent's target. The opponent tries to block or catch the ball. A point is scored if the ball sticks to the target. Once the opponent has the ball, he can throw the ball at the other target. For more challenge use more balls.

Tramp Tag. Three to eight balls of varying or equal size and bounciness are used. Players bounce about the court in any direction. They start with 10 balls losing one each time a ball touches them. The last player left with a ball wins. Once a player is out he leaves the court. For more challenge, use elastic cords stretched across the court obstacles.

Tramp Basket. A cord is stretched across the court at below waist height. A small basket with a net is securely attached to one pole. A soft, bouncy Nerf-type ball that can easily pass through the net is used. Players either take turns a predetermined number of times and the one with the most baskets wins or a half-court game can be played. In the half-court game, the player on offense shoots behind the cord. The player on defense may not goal tend.

Tether Tramp I. The ball is suspended from above the court by a bungee cord. A cord also extends from the top cord down to a cord across the bottom. The ball is a medium-sized, bouncy, light-weight, plastic ball. Each player is in one-half of the court as marked by the lower cord, and remains there the entire game. A player wins by hitting the ball until it wraps tightly and completely around the vertical cord suspended in the center of the court.

Tramp Duel. Two nets are securely attached to poles located across from one another. One cord runs across the court at below waist-height, dividing the court into two halves, with the nets at the back of each. The ball is medium-sized and soft. Each player remains in his half during the entire game. Points are scored when a player makes a basket. The defender may block a shot, but may not goal-tend.

High Tramp. A cord is stretched across the net, starting out at waist height. Just like the High Jump, each player attempts to jump over the cord from one side to the other, without touching the cord. Each player gets three attempts to jump each

height. If both succeed, the cord is raised. The player to make the greatest height wins.

Tether Tramp II. Similarly to Tether Tramp I, the ball is attached to a cord which is suspended from an overhead cord. The object is to throw the ball around the horizontal cord. Each player tries to wrap up the ball in opposite directions.

Tramp Touch. A cord is stretched across the court. From it, balls are hung at graduated heights. This allows small children the challenge of jumping up and hitting them at progressively greater heights. They can see if they really did touch or not because the ball will be swinging. For greater challenge with larger kids, hang the balls from the upper part of the TrampBrella poles.

Tramp Throw. Cords are stretched in a grid across the top of the court. Game is played by jumping up through a certain square and throwing the ball down through another specific square.

Tramp Slide Each player attempts to slide one of two soft "buoys" across to the other side of the net. If it hits the other side without the opponent blocking it, the player scores a point. For additional challenge, a cord separating the two buoys for both players can be added. This requires the players to jump over the cord to get between the two buoys.

Tramp Hook. Each player has a different colored set of "hooks." The grid at the top of the court is divided into different sections, and they score by putting their hooks in their color-coded spot for each section. Each player is in a separate section, and they rotate when one completes his section.

Tramp Jump. An ordinary garden hose is attached to a water-pressure driven motor suspended in the center of the court. Attached to the motor is a soft rubber foam rod with a soft-weight at one end. The motor turns the foam rod around the court, and the exiting water splashes around the court. Players avoid the foam rod by jumping or ducking. Its height may be varied.

Speed Ball. Two players have two different colored sets of balls, and a matching colored basket. They race to grab balls of their color (only one may be carried at a time) out of the center basket and put it into their own. Variations can

be played with no center basket, or with players stealing or blocking each others balls.

Jam Ball (one or two players). The enclosure is equipped with two opposed basket ball goals mounted, for example, as shown in FIG. ___. A center line is provided on the trampoline surface at a distance one half way between the goals. A lightweight pneumatic ball is used. Each player defends one goal and shoots for the other. A player with the ball may dribble as in basket ball. To shoot, a player must bounce the ball off the trampoline surface, jump up and catch the bounced ball in midair, and then shoot the ball at the goal before either the player or the ball lands on the surface. To score a point, the player must start the jump from the side of the centerline that is opposite the target goal. For a higher scoring game, it can be established that a player gets an additional bounce, before shooting, after gaining possession of the ball. Goal tending is not permitted. Rebounding determines control of the ball as in basketball.

Having h[illegible] described preferred embodiments of th[illegible]vention, it is anticipated that suitable modifications and additions may be made thereto within the scope of the invention.

For example, there are alternative methods for securing the top line 108 to the posts 44. As shown in FIG. 8, the line 108 can be wrapped around the neck 90 which will keep the line in place without use of a ring.

The attachment of the wall to the posts could be different. Although not preferred, the wall fabric could be attached to the posts with cable ties. Or, as shown in FIG. 9, the wall could be secured directly to the wall with a helical wrap, without an intermediate cord such as bungee cord 128.

Suitable wall-support posts could be mounted so that they extend upwardly from a trampoline frame, and do not extend to the ground. A bracket for this purpose is shown in FIG. 10. With this system, a trampoline support leg is received in the downwardly-facing opening __, the trampoline frame is received in the horizontally-facing openings __, ___, and the wall support post is received in the upwardly-facing opening __. The bracket can be designed to receive free ends of four separate tubing members as illustrated. Or, a passage way could be provided through the bracket, horizontally and/or vertically, so that the bracket could be secured at a location between the free ends of a tube. For example, if the bracket has a vertical passageway, a single tube could extend through the passageway and, if the tube is sufficiently long, be used for both the trampoline leg and the wall support post. Likewise, if there is a horizontal passageway, the bracket could be secured to a frame segment at a location between the ends of the segment. The bracket shown in FIG. 10 is made of two sheet metal members which bolt together to sandwich tube members therebetween. Other suitable brackets, as shown in FIGs. 11-12, are a metal cross connecters of the type used in plumbing joints.

An activity computer could be provided to process data acquired from sensors, of the type shown in FIGS. 13-14, attached to the trampoline and enclosure system. The computer could be linked to a keypad or other user input device. Such a computer would use the inputted information, such as time intervals between

bounces and number of bounces, to record and calculate information of use to the user, such as calories consumed by the user, game scores, and the like.